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PROCEEDINGS.

Seven hundred and forty-second Meeting.

May 24, 1881. — ANNUAL MEETING.

The PRESIDENT in the chair.

The Treasurer and Librarian presented their annual reports.

The following gentlemen were elected members of the Academy : —

Alvan Graham Clark, of Cambridge, to be a Resident Fellow in Class I., Section 2.

Francis Blake, of Auburndale, to be a Resident Fellow in Class I., Section 3.

Lucien Carr, of Cambridge, to be a Resident Fellow in Class III., Section 2.

Fordyce Barker, of New York, to be an Associate Fellow in Class II., Section 4.

John Shaw Billings, of Washington, to be an Associate Fellow in Class II., Section 4.

Jacob M. DaCosta, of Philadelphia, to be an Associate Fellow in Class II., Section 4.

Alfred Stillé, of Philadelphia, to be an Associate Fellow in Class II., Section 4.

Manning Ferguson Force, of Cincinnati, to be an Associate Fellow in Class III., Section 3.

William Graham Sumner, of New Haven, to be an Associate Fellow in Class III., Section 3.

William Stubbs, of Oxford, to be a Foreign Honorary Member in Class III., Section 3, in place of the late Thomas Carlyle.

The annual election resulted in the choice of the following officers:—

JOSEPH LOVERING, *President*.
 OLIVER W. HOLMES, *Vice-President*.
 JOSIAH P. COOKE, *Corresponding Secretary*.
 JOHN TROWBRIDGE, *Recording Secretary*.
 THEODORE LYMAN, *Treasurer*.
 SAMUEL H. SCUDDER, *Librarian*.

Council.

WOLCOTT GIBBS,
 EDWARD C. PICKERING, } of Class I.
 CHARLES W. ELIOT,

HENRY W. WILLIAMS,
 GEORGE L. GOODALE, } of Class II.
 HENRY P. BOWDITCH,

FRANCIS J. CHILD,
 CHARLES G. LORING, } of Class III.
 EDWARD ATKINSON,

Rumford Committee.

GEORGE B. CLARK. JOSEPH LOVERING,
 JOSIAH P. COOKE, JOHN M. ORDWAY,
 WOLCOTT GIBBS, EDWARD C. PICKERING,
 JOHN TROWBRIDGE.

Member of Committee of Finance.

THOMAS T. BOUVÉ.

On the motion of the Corresponding Secretary it was
Voted, That when this meeting adjourn, it adjourn to the
 second Wednesday in June next.

The following papers were presented by title:—

“The Spectrum of Arsenic.” By O. M. W. Huntington.

“Researches on the Compound Inorganic Acids.” Paper No. 3. By Wolcott Gibbs.

“Spectra of Celestial Objects.” By Edward C. Pickering.

Seven hundred and forty-third Meeting.

June 8, 1881. — ADJOURNED ANNUAL MEETING.

The PRESIDENT in the chair.

The President appointed the following standing committees:—

Committee of Publication.

ALEXANDER AGASSIZ, JOSIAH P. COOKE,
JOHN TROWBRIDGE.

Committee on the Library.

HENRY P. BOWDITCH, WILLIAM R. NICHOLS.
EDWARD C. PICKERING.

Auditing Committee.

HENRY G. DENNY, ROBERT W. HOOPER.

The Chairman of the Rumford Committee presented the following Annual Report:—

“During the last year (May 1880–May 1881) investigations have been made by members of the Committee, individually or collectively, on the Magnetizing and Demagnetizing of Metals; on Atmospheric Refraction; on the Dynamo-electric Machine; and by Professor Langley on Radiant Energy, with his new instrument, the Bolometer. Mr. Edmands has been employed to do some additional work on the measurements of Rutherford’s Photographic Spectrum, and on a comparison of observations with the spectrometer.

"The Committee have authorized the payment by the Treasurer of the following sums out of the income of the Rumford Fund: —

To Professor Trowbridge for apparatus, &c., for magnetic experiments,	\$97 65
To Dr. Gibbs for a new dynamo-machine,	115 86
To Professor Langley for apparatus, &c.,	300 00
To Mr. Edmands for work on Rutherford's photograph,	4 31
To Mr. Edmands for work on spectrometer,	30 00
To Philadelphia Mint for medals (including engraving and case),	359 79
To Mr. Edmands for work on Atmospheric Refraction,	24 36
Total,	<u>\$931 97</u>

"The Committee have also authorized the payment from the Rumford Fund of that portion of Mr. Wilson's bill, amounting to \$286.23, which is charged for the printing of the papers 1, 2, 7, 10, 13, 18, 21, and 22, in Volume XVI. of the Proceedings of the Academy, these being on subjects connected with Light or Heat; and also the payment of \$400.00, at the order of the Librarian, for the purchase of books on Light or Heat.

"Respectfully submitted,

"JOSEPH LOVERING, *Chairman*.

"BOSTON, June 8, 1881."

In accordance with the recommendation of the Rumford Committee, one thousand dollars (\$1000) were appropriated from the income of the Rumford Fund for investigations on Light and Heat during the current year.

On the motion of the Treasurer it was

Voted, to appropriate: —

For publishing Proceedings,	\$1100
For publishing Memoirs,	900
For Books and Binding,	1250
For General Expenses,	2200
	<u>\$5450</u>

The following paper was presented by title: —

"Eclipses of Jupiter's Satellites." By Edward C. Pickering.

Seven hundred and forty-fourth Meeting.

June 22, 1881. — SPECIAL MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary read the following letter : —

“MASSACHUSETTS CHARITABLE MECHANIC ASSOCIATION,
“OFFICE OF THE PRESIDENT, BOSTON, June 9, 1881.

“PROFESSOR JOSIAH P. COOKE.

“DEAR SIR, — I have the honor to request, in behalf of the Board of Managers of the Fourteenth Exhibition of the Massachusetts Charitable Mechanic Association, that the Fellows of the American Academy of Arts and Sciences should do them the honor to bestow, this fall, the Association's ‘Grand Medal,’ for that single exhibit in the ensuing display most conducive to human welfare.

“Such medal will be established by the Association, and we are desirous of its bestowment in a manner that will add to its value; and it has seemed to our Board of Managers that no more renowned or impartial body could be selected than the Academy which you represent.

“Should this suggestion meet the approval of your Associates, and the duty be undertaken by your body, I shall be very happy to confer further with you in regard to the matter.

“I am, very respectfully,

“Your obedient servant,

“CHARLES W. SLACK,

“President.”

On the motion of Professor Cooke it was

Voted, To appoint a Committee of seven Fellows of the Academy who, after conferring with the authorities of the Charitable Mechanic Association, shall have full power to decide whether it is advisable for the Academy to accept the proposed trust, and shall report their decision or action to the Academy at their stated meeting in October.

The President appointed the following Committee in accordance with this vote:—

THEODORE LYMAN, *Chairman.*

HENRY P. BOWDITCH,

EDWARD C. PICKERING,

WOLCOTT GIBBS,

JOHN TROWBRIDGE,

HIRAM F. MILLS,

CHARLES H. WING.

Seven hundred and forty-fifth Meeting.

October 12, 1881. — STATED MEETING.

The PRESIDENT in the chair.

Letters in acknowledgment of election were received from Messrs. F. Blake, Billings, Brown-Séquard, Da Costa, Force, Stillé, Stubbs, and Sumner.

Mr. Lyman presented an informal Report from the Committee on the "Grand Medal" of the Massachusetts Charitable Mechanic Association, which, in substance, was that the Committee had found certain exhibits which seemed to warrant the conferring of such a medal.

On the motion of Mr. Scudder it was

Voted, That the Report of the Committee be accepted, and that the Academy undertake the responsibility which the Charitable Mechanic Association desires to impose upon it; also,

Voted, That the Committee on the "Grand Medal" continue their work, and present their final Report at the next meeting of the Academy.

The following gentlemen were elected members of the Academy: —

Clarence John Blake, of Boston, to be a Resident Fellow in Class I., Section 3.

Thomas Gaffield, of Boston, to be a Resident Fellow in Class I., Section 3.

Frederic Walker Lincoln, of Boston, to be a Resident Fellow in Class I., Section 4.

William Otis Crosby, of Boston, to be a Resident Fellow in Class II., Section 1.

William Harmon Niles, of Cambridge, to be a Resident Fellow in Class II., Section 1.

Charles Rockwell Lanman, of Cambridge, to be a Resident Fellow in Class III., Section 2.

John Davis Long, of Hingham, to be a Resident Fellow in Class III., Section 2.

John Cummings, of Woburn, to be a Resident Fellow in Class III., Section 3.

Henry Draper, of New York, to be an Associate Fellow in Class I., Section 2.

The following paper was presented : —

“On the Co-efficient of Expansion of a Bar of Tempered Steel which has its Graduated Surface protected by a Covering of Thin Glass.” By William A. Rogers.

Voted, That when the Academy adjourn, it adjourn to the second Wednesday in November, and that that meeting be an Adjourned Stated Meeting.

Seven hundred and forty-sixth Meeting.

November 9, 1881. — ADJOURNED STATED MEETING.

The PRESIDENT in the chair.

Letters were read from Messrs. C. J. Blake, Draper, Gaffield, Lanman, and Long, acknowledging their election into the Academy.

The chair announced the death of Mr. John A. Lowell.

Mr. Theodore Lyman read the

Report of the Committee on the “Grand Medal” of the Massachusetts Charitable Mechanic Association.

“The judges first agreed that the exhibit for the grand award must possess invention not only original but novel, because the admission of old inventions to competition would render the task of selection hopelessly complicated, and because such admission would be against the

intention of the Association which offered the Medal. In order to get a knowledge of the contents of the Exhibition, the manuscript catalogue was examined, and all exhibits that might be candidates were noted and inspected. There was also distributed to the exhibitors the following circular:—

“‘*The Grand Gold Medal.*— Boston, Oct. 6, 1881. — The Committee appointed by the American Academy of Arts and Sciences to consider the award of a Grand Medal, by the Massachusetts Charitable Mechanic Association, “for the single exhibit most conducive to human welfare,” wish to obtain information for their guidance. If you desire to compete for this Medal, please to state your claims by filling the following blanks:—

“‘1. Date of patent and time of introduction.

“‘2. Brief description of the exhibit, with a statement of the reasons of its superiority, and of its contribution to human welfare.

“‘Replies should be directed, before October 20, to Theodore Lyman, Chairman, American Academy of Arts and Sciences, Boston.’

“The circulars returned were read and considered. When, by gradual elimination, the candidates had been reduced to three or four, special reports were prepared on them, and these reports were discussed at a meeting of the Committee. A ballot was then taken, which resulted in the selection, by a unanimous vote, of the exhibit of results of the ‘testing machine,’ now at the United States Arsenal in Watertown, and designed and constructed by Mr. Albert H. Emery (a civil engineer), as the ‘single exhibit most conducive to human welfare,’ and therefore the proper one to receive the Grand Medal.

“The purpose of the testing machine is to show the effect of a given push or a given pull on any solid material. The specimen, placed horizontally, is squeezed or pulled at pleasure, and the power at work is measured in two forms:—

“1. The force used to hold the specimen in place, and that exerted in the straining press, is indicated by a gauge.

“2. The strain on the specimen is shown by a weighing apparatus.

“Considered purely as a testing machine, it is the latter apparatus only which is directly important; but viewed as a construction capable of several uses (which uses are claimed by the inventor), the first contrivance or gauge becomes of consequence, because it can be applied to measure with accuracy many sorts of pressure, such as that of steam or that of the air. In like manner the weighing apparatus may, *mutatis mutandis*, be used as a delicate scale.

“It would not be proper to give a detailed description of the structure, because there are patents on certain portions of it that are not yet secured ; but a general sketch of it is admissible.

“This testing machine was ordered in June, 1875, by the United States Board on the Testing of Iron and Steel, of which Colonel T. T. S. Laidley, U. S. A., was chairman. It was completed about three years ago. The first patent was in 1872, and others have since been granted or are now pending. The machine has as its source of pressure a hydraulic accumulator ; and by this pressure the specimen is held in place, and a steady and easily controlled strain is imparted to it through a hydraulic press.

“This straining press has a double action, which, in connection with the alternating bed and platform of the scale, allows a test, either by compression or tension, without the addition of intervening parts. The strain upon the specimen is transmitted directly and without friction to liquid supports capable of receiving a strain of 1,000,000 pounds, without exceeding the safe limit of strain for diaphragms intended for perpetual use.

“The pressure in these liquid supports is communicated, without loss and with great sensitiveness, to other supporting chambers acting directly, and still without friction, through a single pair of levers having steel-plate fulcrums. These last, as distinguished from knife-edge fulcrums, are not subject to injury from load or shock ; may be protected from corrosion ; allow a free movement of the beam ; may be adjusted exactly ; and are durable, since their motion is molecular and far within the limits of elasticity. By means of similar fulcrums, the strain — now reduced — is communicated to the scale beam, and motion is imparted to the indicator rod, where a variation of a single pound is distinctly visible, if the load be small ; and for the maximum load of 1,000,000 pounds, a variation of $\frac{1}{250,000}$, or four pounds, may be noted ; while by an admirable system of levers the total weight is recorded on an indicator plate. The specimen tested may even be thirty feet in length, — a limit which would include many built-up structures, such as columns, trusses, and bridge spans.

“Among the proof experiments to which this machine was subjected by the United States Board, the following may be quoted : —

“1. A forged link of hard wrought iron, five inches in diameter between the eyes, was slowly strained in tension, and broke short off with a loud report at 722,800 pounds.

“2. In order to see if the weighing parts had been disturbed by the

recoil, which was obviously near the greatest recoil the machine will ever suffer, a horsehair was next tested. It was $\frac{7}{1000}$ of an inch in diameter, it stretched thirty per cent, and broke at one pound.

"3. Specimens were subjected to 1,000,000 pounds compression.

"4. Delicate structures, such as eggs and nuts, were tested in compression.

"The results of these and of many other proof experiments demonstrate the efficiency of this testing machine. Its action as a whole does not end its usefulness, for its separate parts may be adapted to other modes of testing. It is evident, for example, that the bed and platform, with the four supporting chambers, could be removed and built in as one of the arch stones in a great arch, where the pressure at that point would be indicated by the scale beam, and by a slight modification of the connections, there might be shown the position of the resultant line of pressure under either a still or a moving load. Were the same parts buried in the rear of a retaining wall, they would measure the thrust; and the effect of that thrust would be shown if they were built into the lower course of that wall.

"The gauges in this machine which measure the pressure on the specimen holders, and that in the straining press, constitute in themselves a very promising form of steam gauge. As they stand, they are capable of indicating from one pound to the square inch to 3,600 pounds, without straining any part beyond the safe limit of elasticity. The need of an accurate steam gauge which will not degenerate is illustrated by the fact that the United States Board appointed to study the causes of the bursting of steam boilers reported that its results were entirely unreliable, because no steam gauge could be found on which dependence could be placed.

"It only remains to indicate in what way and to what degree the testing machine is conducive to human welfare.

"It lessens the risk of life and the cost of construction, by condemning every dangerous part and exposing each excess of material. Structures may have various faults: (1) They may be too weak, and therefore liable to give way at all points. (2) They may be strong enough in some parts but weak in others, where they are ready to break. (3) They may be everywhere too strong, in which case the weight of useless material must be subtracted from the load they ought to bear. In the first instance, the structure is dangerous and too cheap; in the second, it is dangerous and in certain places too cheap; in the third, it

is dangerous (because overweighted) and too costly. Only by such an instrument as a testing machine can these faults be avoided.

"Our mode of life is highly artificial, and is daily growing more so. We are everywhere dependent on machinery and on complex structures, be they railroads, steamboats, manufactories, or great public buildings. These things are absolutely necessary, and make the foundation of human happiness; but they bring corresponding perils, so that a community which has had public works lives in constant danger. Such danger has hitherto been considerable, even in presence of the best precautions, because there were no means for accurately determining the strength of the materials employed. But with this testing machine there can no longer be an excuse for materials weak in themselves, or improperly proportioned. By its use every part may be made safe, from the simple rail to the most complex bridge, from the humble hand-car to the largest locomotive, and from the plain column to the most elaborate trussed roof.

"A machine which can guarantee the safety of most of our artificial surroundings may properly be called conducive to human welfare.

"THEODORE LYMAN,
EDWARD C. PICKERING,
CHARLES H. WING,
JOHN TROWBRIDGE,
HIRAM F. MILLS,
HENRY P. BOWDITCH."

The Report of the Committee was accepted. A vote was then taken, which resulted in the selection, unanimously, of the exhibit of results of the testing machine now at the United States Arsenal in Watertown, and designed and constructed by Albert H. Emery, civil engineer, as the "single exhibit most conducive to human welfare," and therefore the proper one to receive the Grand Medal of Honor.

Luigi Palma di Cesnola, of New York, was elected an Associate Fellow in Class III., Section 4.

The following papers were read:—

"On the Scientific Use of the Telephone." By John Trowbridge.

"On a Machine for Reproducing and Transmitting Vowel and Consonant Sounds." By Amos E. Dolbear.

The following paper was presented by title : —

“ On Indirect Determination of Chlorine and Bromine by Electrolysis.” By Leonard P. Kinnicutt.

Seven hundred and forty-seventh Meeting.

December 14, 1881. — MONTHLY MEETING.

The PRESIDENT in the chair.

The President informed the Academy that a letter had been received from General L. P. di Cesnola, acknowledging his election as Associate Fellow ; also a letter announcing the death of Herr Geheimerath J. C. Bluntschli, D.C.L., of Heidelberg, Foreign Honorary Member.

The following papers were presented : —

“ On Curcumin.” By C. L. Jackson and A. E. Menke.

“ A Comparison of the Harvard College Observatory Catalogue of Stars for 1875 with the Fundamental Systems of Auwers, Boss, Safford, and Newcomb.” By William A. Rogers.

“ On Maxwell’s Law of the Distribution of Energy among the Molecules.” By N. D. C. Hodges.

Professor Wolcott Gibbs announced his discovery of the following new complex acids : —

Arsenoso-molybdic acid,	Vanadoso-tungstic acid,
Arsenoso-tungstic acid,	Vanadoso-phosphoric acid,
Antimonoso-molybdic acid,	Vanadoso-arsenic acid,
Antimonoso-tungstic acid,	Vanadoso-antimonic acid,
Vanadoso-molybdic acid.	

All these acids have well-defined series of salts.

Seven hundred and forty-eighth Meeting.

January 11, 1882. — STATED MEETING.

A quorum was not present, and the Academy was not called to order.

Seven hundred and forty-ninth Meeting.

February 8, 1882. — MONTHLY MEETING.

The PRESIDENT in the chair.

The chair announced the following deaths : —

Lewis Henry Morgan, Dec. 17, 1881 ; Edward Reynolds, Dec. 25, 1881 ; John William Draper, Jan. 4, 1882 ; Richard Henry Dana, Jan. 6, 1882 ; Theodor Schwann, Jan. 11, 1882.

The following papers were presented : —

“On a New Telephone.” By A. E. Dolbear.

“Conventionalism in Ancient American Art, Illustrated by Specimens of Pottery from the Burial Mounds.” By F. W. Putnam.

“On Interference Bands in Mapping Spectra.” By C. E. Kelley. (By invitation.)

“On the Distribution of Energy among the Particles of a Gas.” By N. D. C. Hodges.

The following papers were presented by Henry B. Hill by title : —

1. “Dibromacrylic Acid.”
2. “Dichloracrylic Acid.”
3. “Relations of Dibromacrylic Acid to Two Different Tribromopropionic Acids.”
4. “Certain Tetrasubstituted Propionic Acids.”
5. “On the Constitution of the Substituted Acrylic Acids.”

The following papers by Asa Gray were read by title : —

1. “Studies of Solidago and Aster.”
2. “*Novitiæ Arizonicæ*, &c. Characters of New Plants, chiefly from Recent Collections in Arizona and Adjacent Districts.”

Mr. Charles F. Mabery presented by title,

“Contributions from the Chemical Laboratory of Harvard College.”

Seven hundred and fiftieth Meeting.

March 8, 1882. — STATED MEETING.

The PRESIDENT in the chair.

The Secretary of the Society of Arts having received a letter from General Hazen, Chief Signal Officer, U. S. A., in which the co-operation of that Society with the weather-service was invited, was instructed by the Society to ascertain, informally, whether the American Academy of Arts and Sciences, being the older and more strictly scientific body, would relieve the Society of Arts from the invited responsibility.

The following Committee was appointed by the chair to consider the proposition of the Society of Arts and to confer with the Society in regard to General Hazen's letter: —

WILLIAM WATSON, *Chairman.*

EDWARD C. PICKERING,

WILLIAM H. NILES.

The following papers were presented: —

“On the Absorption of Light by Glass.” By Edward C. Pickering.

“Ancient Peruvian Pottery, with Reference to the Characteristic Art of the People.” By F. W. Putnam.

“Calibration of Thermometers.” By Silas W. Holman, presented by Professor Charles R. Cross.

“The Crystalline Form of Tribromacrylic Acid.” By W. H. Melville (by title).

Seven hundred and fifty-first Meeting.

April 12, 1882. — MONTHLY MEETING.

The PRESIDENT in the chair.

The Council recommended that the name of Frederick W. Putnam be transferred from Class II., Section 3, to Class III., Section 2. The Academy confirmed this recommendation.

The chair announced the death of Saint-Julien Ravenel, of Charleston, Associate Fellow of the Academy.

The following papers were presented:—

“On the Young Stages of some Osseous Fishes. Part III.”
By Alexander Agassiz.

“Wages as a Standard of Cost.” By Edward Atkinson.

“On the Construction and Comparison of Three Standard Metres.” By William A. Rogers.

“Note on Thermodynamics.” By John Trowbridge.

“On a Modification of the Micrometer Level.” By J. Rayner Edmands.

“On the Spirit-Level considered as an Instrument of Precision.” By William A. Rogers.

“On the Colors and Patterns of Insects.” By Hermann A. Hagen.

“On the Conditions of Electric Lighting.” By N. D. C. Hodges.

Seven hundred and fifty-second Meeting.

May 10, 1882. — MONTHLY MEETING.

The PRESIDENT in the chair.

The President announced the death of Henry Wadsworth Longfellow, Ralph Waldo Emerson, and Charles Robert Darwin.

Dr. Gray referred to a communication from Mr. Winthrop, who represented the Academy at Darwin's funeral, and who mentioned that another Fellow of the Academy, Mr. Lowell, U. S. Minister, was also present.

The following papers were presented:—

“On Telegraphing over Great Distances.” By N. D. C. Hodges.

“On the Limit of Visibility of Fine Lines Ruled on Glass.”
By William A. Rogers.

The following papers were presented by title:—

“On the Wedge Photometer.” By Edward C. Pickering.

“On a New Type of Insects.” By Samuel H. Scudder.

“Curcumin.” Second paper. By C. Loring Jackson and A. E. Menke.

“Tumeric Oil.” By C. Loring Jackson and A. E. Menke.

“On the Fatigue of Small Spruce Beams.” By F. E. Kidder.

Mr. Sereno Watson presented by title the following contributions to North American Botany:—

1. “List of Plants from Southwestern Texas and Northern Mexico, collected chiefly by Dr. E. Palmer in 1879–80.”

2. “Descriptions of New Species of Plants from our Western Territories.”